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# (54) Flexible suspended silo

(57) A container or silo 2 for bulk materials such as flour consists of a flexible bag suspended from a supporting frame 1 and has at least one upper storage portion 2*a* and a lower discharge portion 2*b* which links thereto, the length of the upper storage portion 2*a* corresponding approximately to the overall height of the supporting frame 1 or to the headroom. In order to permit complete emptying of the silo the wall is substantially impermeable to air so that, upon emptying, through suction tube 5, the silo is closed on all sides save for the outlet where the suction tube connects.

FIG. 3

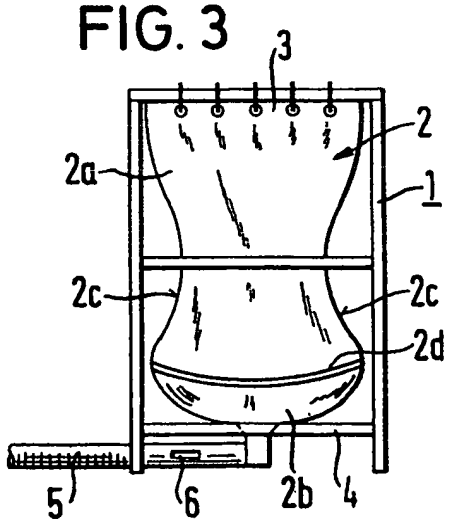


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FIG. 1

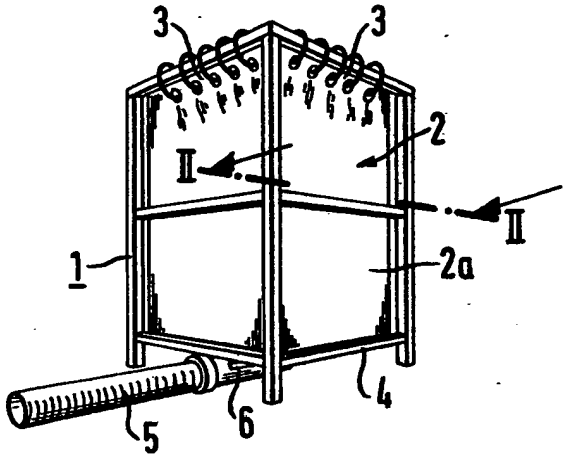



FIG. 2

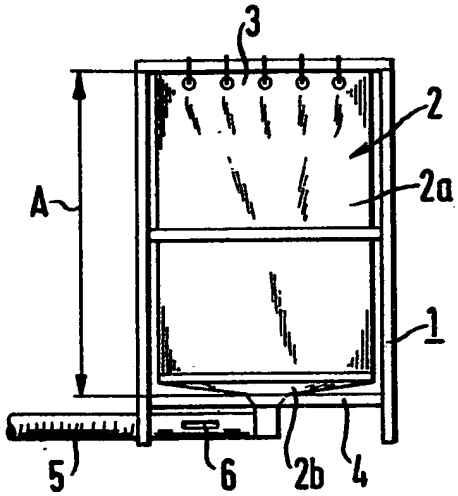



FIG. 3

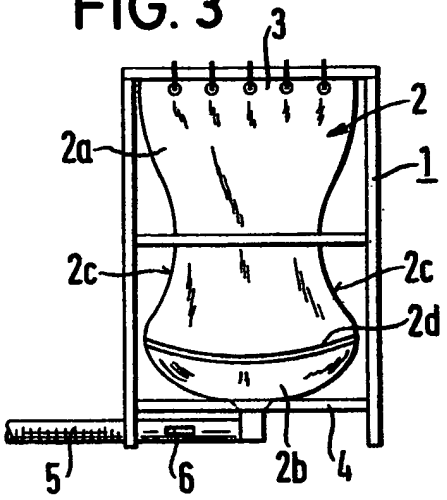
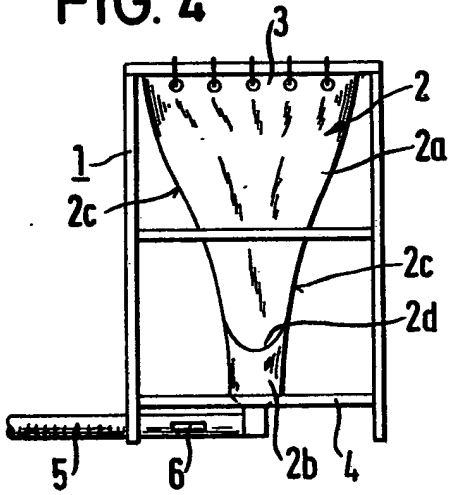



FIG. 4



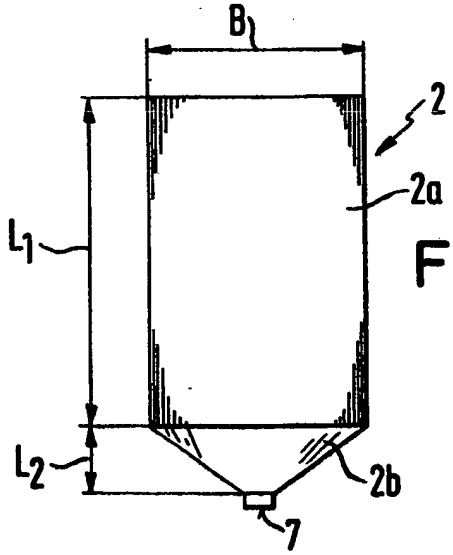




FIG. 5

FIG.6

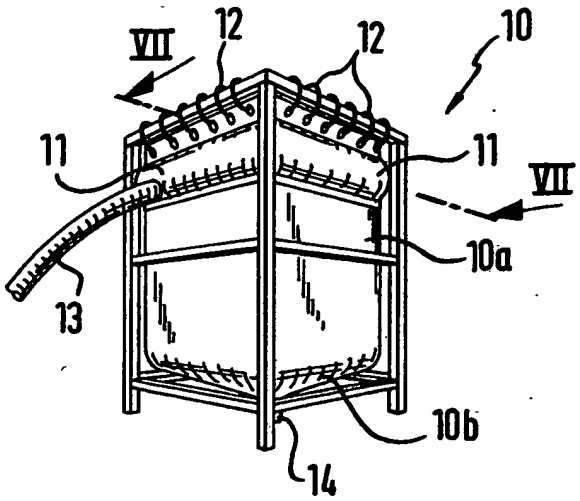



FIG.7

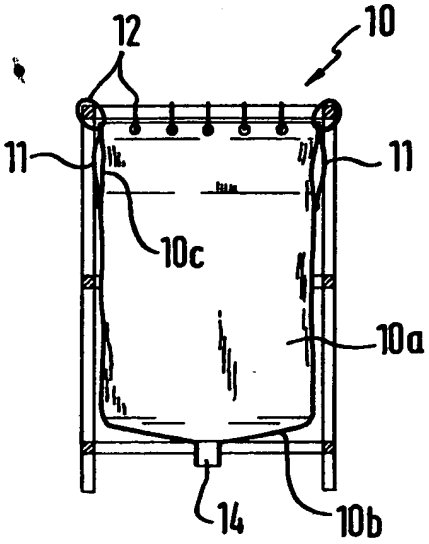



FIG.8

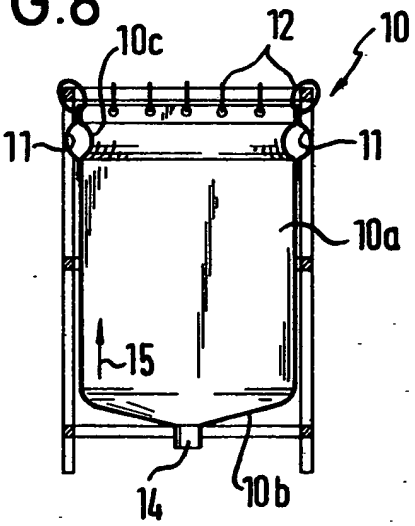



FIG.9

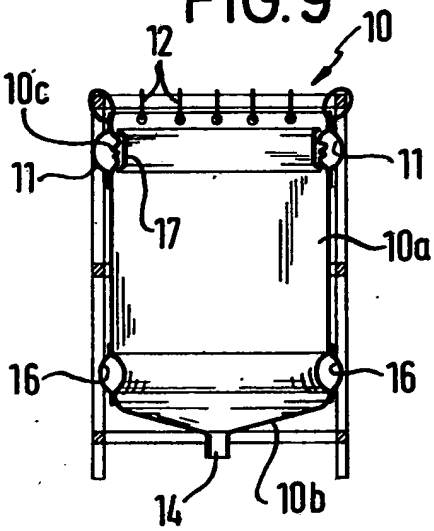
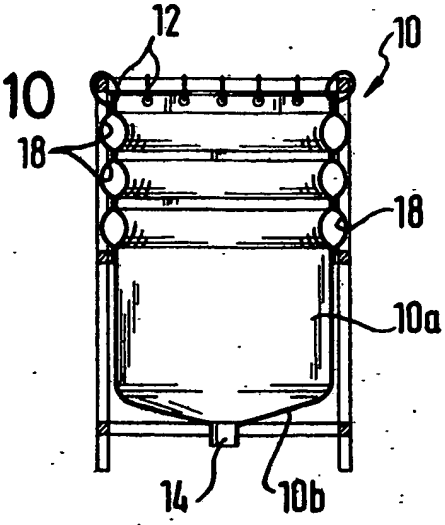



FIG.10



SPECIFICATION

**Flexible suspended silo**

This invention relates to a container or silo for bulk material, such as flour, which consists of flexible material is bag-shaped in design, can be suspended from a supporting frame and has at least one upper storage portion and a lower discharge portion which connects thereto, the length of the upper storage portion corresponding approximately to the overall height of the supporting frame or headroom.

A known silo of this kind has a funnel-shaped discharge portion and a lifting device must be provided to act on the silo between the lower and upper storage portions so as to push the upper storage portion together, i.e. into concertina conformation, during the discharge operation, so that the lower funnel-shaped discharge portion can unfold. With this known arrangement it is possible, when the silo is filled, to make use of the entire cross-section of the silo over its whole height despite the use of a funnel-shaped discharge portion.

However, the disadvantage of the known arrangement is that the lifting device, which is essential, needs additional mechanical means which are subject to wear and are complicated and expensive. More particularly when a silo of this kind is used as a transportation container, the weight of the lifting device, which always has to be co-transported, is a special disadvantage.

An object of the invention is, accordingly, to provide a silo of the kind mentioned in the introductory paragraph in such a way that a lifting mechanism is provided which is far less expensive to construct and is far lighter than hitherto.

In accordance with the invention, this object is achieved in that the wall of the silo is substantially impermeable to air, and in that, upon emptying, the silo is closed on all sides save for a discharge outlet so that emptying of the silo may be effected by suction.

With this arrangement, emptying of the silo is achieved more rapidly, than by methods relying solely on the weight of the material being discharged since by reason of the impermeability to air of the wall, suction may readily be applied to the interior of the silo. Thus, during extraction the upper storage portion contracts in length as the walls draw together, whilst at the same time the lower discharge portion, which is preferably funnel-shaped, is unfolded.

In this way a silo is provided in which, in a surprising manner, a mechanical lifting device, in whatsoever form, can be dispensed with, the necessary lift being brought about, as it were, automatically through the building up of the suction within the silo by reason of the impermeability to air of the silo wall. Thus, the silo in accordance with the invention makes do without an additional lifting device and therefore does not have the above-mentioned disadvantages of the known silo. It is cheaply and is less susceptible to breakdown than the known silo.

Advantageously, in cases where the lower discharge portion is funnel-shaped, a conveying tube connected thereto is provided with a controllable duct for secondary air intake in order to be able to initiate the discharge and conveying of material and also to be able to control the further conveying.

The arrangement in accordance with the invention can be applied to different overall heights and geometric shapes of silo. It is, however, advantageous, in the case of a funnel-shaped discharge portion, if the ratio of the length of the funnel-shaped portion to the length of the upper storage portion amounts to about 1:3 to 1:5 in the production state of the silo.

Advantageously, in the case of a silo having a rectangular or square cross-section, the length of the upper storage portion is not greater than 3.5 times the width of the narrowest side of the silo. In the case of a circular cross-section silo, the length of the upper storage portion is advantageously not greater than 3.5 times the diameter of the silo.

The suction pressure or vacuum pressure to be used is dependent both upon the material that is to be extracted and upon the material of the silo wall, i.e. upon the permeability thereof to air. It must in any case be sufficient to empty the silo completely.

It is particularly surprising that the silo in accordance with the invention need not have a funnel-shaped discharge portion. In one embodiment, the silo of the invention may, in the initial state, have a flat base. By reason of the suction applied during the extraction operation this base is deformed by the raising of the entire silo (the entire length of which forms the storage portion) into a conical discharge portion which fosters the extraction.

In order to assist the lifting movement, brought about by the contraction of the upper storage portion during the extraction, and preferably towards the end of the emptying operation, the upper storage portion of the silo is preferably provided with an impermeable encircling sleeve which is attached to the wall of the silo in substantially horizontal disposition and in a manner impermeable to air such that air can be blown in between the wall of the silo and the sleeve, yet when no such air is blown in the sleeve lies flat against the surface of the silo wall.

With this arrangement, when air is blown in between the sleeve and the silo wall, i.e. when the sleeve is inflated, the sleeve arches outwards, whilst the silo wall underlying the sleeve arches inwards, so that an approximately circular cross-section arises. This shortens the length of the upper storage portion of the silo by the difference between the normal stretched silo wall and the arched silo wall, the difference usually amounting to about one-third of the length original stretched

portion is enhanced and extraction is favouredly shortening the wall of the upper storage portion.

Advantageously the sleeve is situated on the silo wall in the region of the upper end of the upper storage portion, since contraction of the silo would be hindered if the sleeve were disposed in the central region of the storage portion because the inflated head would tend to draw the collapsing silo walls apart again.

The sleeve should, of course, be so designed that the cross-sectional shape of the silo is not varied, i.e. in the case of a silo having a circular cross-section the sleeve is formed as a continuous circle, whilst, in the case of a silo having a triangular, rectangular or square cross-section, the sleeve is provided with mitre-like corners.

In order to achieve a greater lifting movement of the storage portion, it is possible to use a sleeve of considerable width which extends over a large portion of the height of the upper storage portion. However, this can be disadvantageous in that the large bead formed thereby, may, on the one hand, spread too far outwardly when inflated so as to be hindered by the supporting frame or in some other way have insufficient space and, on the other hand, the extraction of the material contained in the silo may be hindered by the large bead projecting inwardly.

It is therefore advantageous if several such sleeves for the formation of several beads of smaller diameter are arranged one above the other on the wall of the upper storage portion of the silo. These sleeves can be inflated and/or deflated simultaneously, successively or independently of one another. With such an arrangement, a greater lift can be achieved and the degree of lift can be controlled in a sensitive manner.

To avoid a large expansion of the inflated bead into the interior of the silo, an inner support is conveniently provided in the region of the sleeve so that the bead cannot expand, or cannot expand too far, into the interior of the silo so that during the lifting movement the silo wall is drawn together in concertina manner in this region. Such a concertina-like drawing-together can be fostered by an appropriate prior folding in the silo wall by pleating, quilting of the like.

In a further embodiment, the silo of the invention may have a relatively small diameter or horizontal cross-section in relation to its length. In a silo of this kind, of course, by reason of the geometrical conditions, contraction of the upper storage portion due to suction pressure does not have such a severe effect as in the case of a relatively short silo, so that additional lift as provided by the sleeve or sleeves mentioned above is advantageous.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a first

II—II of the silo shown in Fig. 1 in the filled condition;

Fig. 3 is a view similar to Fig. 2 showing the same silo during the emptying operation;

Fig. 4 is a view similar to Fig. 2 and showing the same silo towards the end of the emptying operation;

Fig. 5 is a schematic diagram illustrating the dimensions of the same embodiment of the silo of the invention during its production;

Fig. 6 is a perspective view of a second embodiment of the silo of the invention;

Fig. 7 is a cross-section along the line VII—VII of Fig. 6;

Fig. 8 is a cross-section similar to Fig. 7 of the same silo with the cover inflated;

Fig. 9 is a cross-section similar to Fig. 7 of a slightly modified embodiment of the silo of the invention; and

Fig. 10 is a cross-section similar to Fig. 7 of a further embodiment of the silo of the invention.

As shown in Fig. 1, a preferred embodiment of the silo of the invention has a rectangular or square cross-section and is suspended at its upper edges 3 from a supporting frame 1 provided with a base 4, on which the silo stands in the filling and/or filled state. The silo 2 has a wall which is largely impermeable to air and, while the silo 2 is emptied, it is closed on all sides save for a lower discharge outlet 7. The silo 2 is provided on its upper side with a sealable filling opening which is not shown in the drawings.

Arranged underneath the base 4 is a conveying tube 5 to which suction can be applied and which is connected to the central discharge outlet 7 of the silo 2. As shown, the conveying tube 5 can be provided with a controllable inlet duct 6 for the intake of secondary air.

The silo 2 consists of an upper storage portion 2*a* (see Fig. 5), the length $L_1$ of which corresponds approximately to the overall height of the supporting frame 1 or the height of the room in which the silo is to be accommodated. In the case of the exemplified embodiment, the length $L_1$ corresponds to the distance A between the base 4 of the supporting frame and the upper suspension 3.

Linking to the upper storage portion 2*a* is a lower funnel-shaped discharge portion 2*b* (see Fig. 5), which has to be unfolded for the complete emptying of the silo 2. The funnel-shaped discharge portion 2*b* includes the lower discharge outlet 7, which is connected to the conveying tube 5 via a further tube 6 which extends through the base 4 in the connection region.

Fig. 2 shows the silo 2 in the filled state when the lower funnel-shaped discharge portion 2*b* is folded together so that the full cross-section of the silo over its entire available height in the supporting frame 1 is used for storage of bulk material.

Fig. 3 shows the silo 2 at the start of the emptying operation, when the side walls 2*c* of the

The length occupied by the upper storage portion 2*a* is thus shortened, so that the connection 2*d* between the upper storage portion 2*a* and the lower funnel-shaped discharge portion 2*b* is raised and the discharge portion 2*b* unfolds as shown. The funnel-shaped design of the discharge portion 2*b* ensures reliable extraction even from what were originally the bottom corners of the silo.

Fig. 4 shows the same silo 2 toward the end of the emptying. As shown, the silo 2 continues to contract, so that the connection region 2*d* between the upper storage portion 2*a* and the discharge portion 2*b* is now also drawn together and the silo is completely emptied.

Fig. 5 shows the silo 2 in the production state and makes clear the advantageous dimension ratios between the upper storage portion 2*a* and the lower discharge portion 2*b*. The ratio of the length $L_2$ of the funnel-shaped lower discharge portion 2*b* to the length $L_1$ of the upper storage portion is advantageously to about 1:5. Furthermore, in the case of a rectangular or square cross-section silo, such as this, the length $L_1$ of the upper storage portion 2*a* is advantageously not greater than 3.5 times the width B of the narrowest side of the silo. In the case of a circular cross-section silo, the length $L_1$ is advantageously not more than 3.5 times the diameter of the silo.

To improve and complete the extraction the funnel-shaped lower discharge portion (2*b*) (or, in a further embodiment, the flat base of the silo) can be ventilated in a pulsatory manner by means of covers which are impermeable to air and which engage at least partially over the discharge portion (or the base).

In accordance with Fig. 6, a further embodiment 10 of the silo of the invention consists of an upper storage portion 10*a* and a lower funnel-shaped discharge portion 10*b* and has a rectangular or square cross-section.

The upper storage portion 10*a* is provided with an encircling sleeve 11 which lies flat (see Fig. 7) in the initial state and which is connected in an air impermeable manner to air to the air impermeable wall of the silo 10. Air can readily be blown in between the wall of the silo 10 and the sleeve 11. So as to inflate said sleeve the silo 10 is also provided with hangers 12 with which it can be suspended from a supporting frame.

As shown, air may be introduced between the silo wall and the sleeve 11 by means of a hose 13.

Fig. 7 is the section VII—VII in accordance with Fig. 6 and shows the sleeve 11 in the uninflated state. The relevant wall portion 10*c* of the silo which is overlaid by the sleeve 11 is thus in the stretched state. Accordingly, the lower discharge portion 10*b* lies generally horizontal or flat.

As shown, the lower discharge portion 10*b* is provided with a discharge outlet 14, through which the silo can be emptied using suction.

Fig. 8 shows the sleeve 11 in the inflated state such that the relevant wall portion 10*c* arches inwards and the length of the upper storage portion 10*a* of the silo is thereby shortened by about one-third of the length of the wall portion 10*c* in the stretched state. The transitional region between the upper storage portion 10*a* and the lower funnel-shaped discharge portion 10*b* consequently moves upwards by this amount in the direction of the arrow 15, so that the funnel-shaped discharge portion 10*b* is further unfolded.

Although potentially the sleeve 11 can be situated at any desired height on the upper storage portion 10*a* of the silo, it is usually advantageous, as shown in Figs. 7 and 8, to mount this sleeve at the upper end of the silo, in order to prevent the sleeve from hindering the extraction of the material contained in the silo.

It is, of course, possible to provide several sleeves of this kind. In which respect, in the case of the embodiment shown in Fig. 9, a further encircling sleeve 16 is arranged in the transitional region between the upper storage portion 10*a* and the lower funnel-shaped discharge portion 10*b*. In the same embodiment an inner support 17 is shown associated with the sleeve 11 arranged at the upper end of the silo. This inner support 17 is connected to the silo wall and prevents the relevant wall portion 10*c* of the silo from arching too far inwardly. As shown, as a result of this support 17 this wall portion 10*c* is forced together in a concertina manner.

Fig. 10 shows a further embodiment in which three sleeves 18 are arranged one above the other on the upper storage portion 10*a* of the silo 10. With this embodiment a larger lift can be achieved and, moreover, quite sensitive lift control is possible.

In place of the encircling sleeve 16 shown in Fig. 9, a rigid spacer frame can be provided at the transitional point.

**Claims**

1. A container or silo for bulk material, such as flour, which consists of flexible material, is bag-shaped in design, can be suspended from a supporting frame and has at least one upper storage portion and a lower discharge portion connecting thereto, the length of the upper storage portion corresponding approximately to the overall height of the supporting frame or to the headroom, characterised in that the wall of the silo is substantially impermeable to air, and in that, upon emptying, the silo is closed on all sides save for a discharge outlet so that emptying of the silo can be effected by suction.

2. A silo as claimed in claim 1 characterised in that the lower discharge portion is funnel-shaped.

3. A silo as claimed in claim 2, characterised in that a conveying tube connected to the lower funnel-shaped discharge portion is provided with a controllable duct for secondary air intake.

4. A silo as claimed in claim 2 or 3, characterised in that, during production of same

discharge portion to the length of the upper storage portion amounts to about 1:3 to 1:5.

5. A silo as claimed in claim 1 characterised in that th lower discharge portion consists merely of a flat base so that over its entire length the silo has constant cross-section.

6. A silo as claimed in any preceding claim characterised in that, in the event that it has a rectangular or square cross-section, the length of the upper storage portion is not greater than 3.5 times the width of the narrowest side thereof.

7. A silo as claimed in any one of claims 1 to 5 characterised in that, in the event that it has a circular cross-section, the length of the upper storage portion is not greater than 3.5 times the diameter thereof.

8. A silo as claimed in any preceding claim, characterised in that the suction pressure to be used is adjustable as a function of the material that is to be extracted and of the material of the silo wall.

9. A silo as claimed in any preceding claim, characterised in that the funnel-shaped lower discharge portion or the flat base is ventilated in pulsatory manner by means of covers which are impermeable to air and which, at least partially, engage over the discharge portion or the base, to improve and complete extraction of the material.

10. A silo as claimed in any preceding claim, characterised in that an impermeable sleeve encircles the wall of the upper storage portion and is attached thereto in substantially horizontal disposition and in a manner such that air can be blown in between the wall of the silo and the sleeve, yet when no such air is blown in the sleeve lies flat against the surface of the silo wall.

11. A silo as claimed in claim 10, characterised in that air is blown between the silo wall and the sleeve towards the end of the emptying operation of the silo.

12. A silo as claimed in claim 10 or 11, characterised in that the sleeve is situated on the silo wall in the region of the upper end of the upper storag porti n.

13. A silo as claimed in claim 10, 11 or 12, characterised in that, in the case of a silo having a circular cross-section, the sleeve is formed as a continuous circle.

14. A silo as claimed in claim 10, 11 or 12, characterised in that, in the case of a silo having a triangular, rectangular or square cross-section, the sleeve is provided with mitre-like corners.

15. A silo as claimed in any of claims 10 to 14, characterised in that several such sleeves are arranged one above the other on the wall of the upper storage portion of the silo.

16. A silo as claimed in claim 15, characterised in that the sleeves can be inflated and or deflated simultaneously, successively or independently of one another.

17. A silo as claimed in any of claims 10 to 16, characterised in that an inner support for the associated wall portion of the silo is provided in the region of the or each sleeve.

18. A silo as claimed in claim 17, characterised in that the wall portion of the silo associated with the or each sleeve is prepared for folding by being pleated.

19. A silo as claimed in any of claims 10 to 18 which, in relation to its length, has a relatively slight diameter or horizontal cross-section.

20. A silo as claimed in any of claims 2 to 4 as claimed in any of claims 6 to 19 when not dependant on claim 5, characterised in that a rigid distance frame is provided at the transitional point between the storage portion and the funnel-shaped discharge portion.

21. A container or silo for bulk material, such as flour, substantially as hereinbefore described with reference to and as illustrated in Figs. 1 to 5 or in Figs. 6 to 8, or in Fig. 9, or in Fig. 10 of the accompanying drawings.

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